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A BOTANICAL SURVEY OF VANSITTART BAY AND NAPIER BROOME BAY, NORTHERN KIMBERLEY, WESTERN AUSTRALIA

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ABSTRACT

A preliminary botanical survey of the surrounds of Napier Broome Bay and Vansittart Bay in the Northern Kimberley Division of Western Australia was undertaken in 1984. Descriptions of 19 vegetation types and an annotated species list of 438 species are presented. Previous studies of the biological and physical environment are reviewed. A brief history of land use and botanical exploration is presented. Conservation status and botanical significance of the vegetation types are discussed.

CONTENTS

INTRODUCTION

A botanical survey of a remote, inaccessible and poorly documented area of the northern Kimberley Division of Western Australia was undertaken in May 1984 during the 'Dry' season. Descriptions of vegetation types and an annotated list of species supported by voucher collections are presented in this paper. A complete set of voucher specimens is lodged with the National Herbarium of Victoria (MEL). Duplicate specimens for most collections are lodged with the Western Australian Herbarium (PERTH) and with specialists for particular taxa.

LOCALITY

The study area includes the surrounds of Vansittart Bay and Napier Broome Bay (Map 1). The majority of collecting sites for the expedition were confined to the peninsula separating Vansittart Bay and Napier Broome Bay. This peninsula is referred to throughout this paper as the Anjo Peninsula (Map 2). The remainder of the study area is reported from limited observations, published and unpublished accounts, aerial photography and LANDSAT imagery.

The only permanently inhabited settlement within the study area is Kalumburu (latitude 14°15'S, longitude 126°36'E).

CLIMATE

The northern Kimberley Division has a dry monsoonal climate which is discussed in detail by Slatyer (1960) and Beard (1979). The study area has a dry monsoonal climate. The only recording station within the study area is at Kalumburu. The average annual rainfall at Kalumburu is 1050 mm. Rainfall is virtually restricted to the 'Wet' season between October and April. The mean maximum and minimum temperature in November is 37.7°C and 24.5°C and in July is 31.9°C and 14.9°C (respectively the hottest and coldest months) with a virtual absence of frosts. Monthly mean relative humidity reaches a maximum of 74% in February and a minimum of 37% in August. Speck (1960) calculates the mean growing period for useful pasture at 21.7 weeks, commencing on December 6th with a mean variability in commencement date of 2.7 weeks. The growing period exceeds 16 weeks for all available records.

HISTORY

Vansittart Bay and Napier Broome Bay were named by Lieut. Phillip Parker King in October 1819 (King 1827; Lee 1925) whilst surveying the Kimberley coast for the British Admiralty on HMS *Mermaid*. Although Tasman visited the coast in 1644 (Feeken 1973), no details of landings survive and Allan Cunningham, who accompanied King, is credited with making the first botanical collections from the Kimberley (Fig. 1).

Appendix 1 details Cunningham's Vansittart Bay collections. A report on Cunningham's exploration was published as an appendix to King's narrative (Cunningham 1827). Although many previously unknown species were recognised and collected by Cunningham (including at least one still undescribed species), the new species were not prepared for publication. The collections were however available to George

Figure 1. Allan Cunningham (1791-1839), botanist accompanying Lieut. P.P. King's hydrographic surveys of coastal Australia.

Bentham during preparation of his *Flora Australiensis* (Bentham 1863-78). Extracts of Cunningham's diary have been published by Lee (1925).

The next examination of the flora of the study area was in 1901 when Frederick Slade Drake-Brockman led the North Kimberley Expedition, accompanied by Charles Crossland and Dr F.M. House as naturalist and botanist (Brockman 1902). Brockman explored the surrounds of Vansittart Bay and Napier Broome Bay during the first half of October, with a view to establishment of a port to serve the northern Kimberley. Sites in the south-eastern corner of Vansittart Bay and in the south-western corner of Napier Broome Bay were considered worthy of further investigation, and were later explored from the sea (see Perez 1977) during coastal surveys. Although House (in Brockman 1902) obtained a number of botanical specimens whilst attached to the North Kimberley Expedition, these have not been located.

Gardner (1923) observed in regard to House's botanical endeavours that "no notes were taken on the habit or occurrence of species, no precise localities were given, and the specimens themselves were mostly fragmentary."

The first European settlement in the study area was the establishment of the Benedictine Drysdale River Mission at Pago where a landing was made on the 8th July 1908. The history of the Mission, later known as Kalumburu, is admirably detailed by Perez (1977). Visits by naturalists followed shortly after.

On the 14th October 1909, Mr Gerald F. Hill, a collector of plants and birds arrived at the Mission with recommendations from Abbot Torres (of the Mother House at New Norcia) and the Western Australian Museum. Hill was the guest of the monks for a few weeks (and later presented St Gertrude's boarding school at New Norcia with a collection of stuffed and mounted local birds). Many of Hill's plant collections from this period are located at the National Herbarium of Victoria (MEL), and although specimens from Napier Broome Bay have not been located, may be presumed lodged there [as *Calandrinia uniflora*, Hill 114, 14th February 1910, Parry Harbour (on the western side of the Bougainville Peninsula), Western Australia, MEL 2000743].

As Perez notes, "Mr Hill was the first in a long succession of naturalists, anthropologists and scientists from other states of the Commonwealth and from overseas, who visited the Mission in increasing numbers."

By 1914 the Bovril Cattle Station had been established at the Drysdale River with 900 head of cattle, but was abandoned by 1921. The establishment of feral cattle, goats and pigs dates from this period.

Crossland's 1905 expedition with W.V. Fitzgerald was outside the study area — no collections, other than Cunningham's are cited for Vansittart Bay, in Fitzgerald (1919).

W.R. Easton led the 1921 Kimberley Exploration Expedition which was accompanied by Charles Austin Gardner, later to be appointed Western Australian Government Botanist (Fig. 2). The appointment of Gardner to Easton's expedition was "an event which had a momentous influence on his career and thrust him into botanical notice" (Serventy 1970).

Figure 2. Charles A. Gardner (1896-1970), botanist, photographed on surveyor W.R. Easton's Kimberley Exploration Expedition, April-October 1921. (Photo courtesy W.A. Museum).

Gardner's collections from Vansittart Bay and Napier Broome Bay are included as Appendix 2. The report prepared from Gardner's observations and collections (Gardner 1923) provides the first significant vegetation description for the Kimberley.

Settlement in the study area, apart from the Mission, was rarely successful. Experimental cotton farming on Sir Graham Moore Island around 1921 or 1922 was a failure. In July 1926 Willie Reid settled in Vansittart Bay at a place later known as Kingana. Initially Reid lived aboard a lugger, but later settled on shore. Reference to Reid's lifestyle is made in Perez (1970). Reid was removed for security reasons at the beginning of World War Two.

The period from 1942-1947 saw Kalumburu, Pago, Sir Graham Moore Island and Truscott Air Base as centres of military operations. Construction commenced at Truscott in March 1944 for a joint U.S.A.-Australian air base for the recapture of Timor and surrounding areas from the Japanese forces. Truscott officially closed on 16th July 1947, although disposal of war surplus continued for some years (Perez 1970, 1981).

Harold F.M. Broadbent spent most of November and December 1952 at Kalumburu and lodged collections at the Royal Botanic Gardens, Kew, England (K) and at the British Museum — Natural History (BM).

The North Kimberley Survey and Mapping Expedition of 1954 (Morgan 1955) opened road access to Kalumburu, and the CSIRO Land Research Series report prepared from photo-interpretation and from field work in 1954 (Speck et al. 1960) represents a new phase of botanical exploration in the region. Speck and Lazarides' collections are lodged principally in the Australian National Herbarium (CANB), although duplicate collections are also lodged in other Australian herbaria and at the Royal Botanic Gardens, Kew, England.

This period also marks the entrenchment of the cattle industry in the northern Kimberley and the introduction of pigs and goats to Sir Graham Moore Island (Perez 1977).

Acceptable roads and an air-strip have facilitated access to Kalumburu settlement and immediate environs. Contemporary collectors include Lawrie Johnson, Lindsay Prior, Ian Brooker, Lyn Craven, David Symon, Norm Byrnes and Ian Crawford.

Preparation of an inventory of the flora of the Kimberley will be facilitated by the current programs of computerising herbarium records.

Contemporary collections of Beard, Hnatiuk, Kenneally and Wilson have been associated with vegetation surveys (see Previous Vegetation Studies).

NARRATIVE

Apart from the area between Kalumburu and Pago, Vansittart Bay and Napier Broome Bay are remote from any serviceable tracks and vehicle access is prohibitively difficult (Major Joe Macdonald, Royal Australian Army — NORFORCE pers. comm.). Access was obtained by sea and by air.

The current survey party comprised three botanists, S.J. Forbes (National Herbarium of Victoria), E.A. Chesterfield (State Forests and

Lands Service, Victoria) and J.H. Willis (formerly National Herbarium of Victoria), a zoologist, K.C. Norris (honorary at National Museum of Victoria), a land systems analyst, J. Aldrick (Soil and Land Appraisal, Maleny, Queensland), a photographer, Colin Totterdell (CSIRO Div. of Plant Industry) and W.A. Papst, a soil conservationist and radio operator (Soil Conservation Authority, Victoria).

Fieldwork was planned by photo-interpretation of 1969 1:25,000 black and white air-photos, and consideration of logistic constraints. Ten localities were visited and a total of 32 soil profiles described. Observations and collections were restricted to within a few kilometres of each locality (see Map 1).

Fieldwork was carried out between May 19 and May 31, 1984 during the Dry season. Collections of Forbes (nos. 2038-2270), Chesterfield (nos. 239-409) and Willis (243 collections, unnumbered) were made during this period. A few additional collections were made by Papst as voucher specimens for photographs by Totterdell.

The party left Wyndham aboard HMAS *Geraldton* on May 18 and landed at West Governor Island on May 19-20. *Geraldton* then ferried the party to West Bay, to the landing for the abandoned wartime Truscott airbase.

A base camp at West Bay was made from May 20-23. A Bell 412 helicopter on charter to BHP Oil and Gas Division and based at Troughton Island was made available to visit Pauline Bay, Cone Mountain and the base of the Anjo Peninsula on May 22. On May 23-24 HMAS *Cessnock* shifted base camp from West Bay to Pauline Bay. During this same period the party (apart from J.H. Willis and W.A. Papst) were transported by helicopter to Woppinbie Creek and returned to Pauline Bay which remained as base camp until May 28. The helicopter was used to provide access to Pim Hill and the base of the Anjo Peninsula on May 26. *Cessnock* provided access to August Point on May 28, the northern arm of Seaflower Bay on May 29 and to the tip of the Anjo Peninsula near Sharp Point from May 29-31. Aldrick returned to Troughton Island by helicopter on May 31 and the remainder of the party returned to Wyndham aboard *Cessnock* on June 1.

LAND SYSTEMS

A land systems map of the Northern Kimberley at 1:2,000,000 accompanies Speck (1960c). A more detailed land systems map for the most intensively sampled region within the study area, the Anjo Peninsula, drafted at 1:80,000, is provided (Map 2). The Anjo Peninsula covers around 550 sq. km out of the total 54,700 sq. km mapped by Speck and includes six of the nine land systems identified by Speck. An additional prominent land unit (Pago, Unit 2) has also been delineated. A brief description of the seven mapping units is provided below. Note that certain vegetation communities characterise land systems however, others are either more widely distributed (such as the Riverine and *Acacia* Communities) or have a restricted distribution (such as the *Melaleuca viridiflora* Association). The reader is referred to Speck for further details. The vegetation communities are described in a later section.

1. Barton Land System (Bn)

Eucalyptus tectifica Association 1 dominates gently undulating volcanic areas. *Eucalyptus latifolia — E. tetrodonta* Association occurs on more extensive flats. *Eucalyptus grandifolia* and *E. confertiflora* may be present on poorly drained sites (Speck 1960a) but were not recorded in the study area.

Soils are typically skeletal red earths with patches of fine-textured yellow podzolics and grey cracking clays.

Main occurrences of the Barton Land System are in the south-east of the Peninsula, with Napier and Foster Land Systems.

2. Napier Land System (N)

Eucalyptus tectifica Association 1 dominates rugged, dissected volcanic areas. Within the Napier Land System Unit 1 of Speck is subdivided to accommodate an area of sub-laterite etch surface on the volcanics. The Unit (1a) distinguishes areas formerly laterite-capped, now with exposed etch surface at the base of the old deep weathering zone. A few blocks of laterite detritus usually remain.

Soils are predominately skeletal red earths with patches of grey cracking clays.

Main occurrences of the Napier Land System are in the south-east of the Peninsula, with Barton and Foster Land Systems.

3. Foster Land System (F)

Eucalyptus bleeseri — E. tetrodonta — E. miniata Association dominates laterite-capped volcanic country consisting of numerous small mesas and some larger undulating upland areas, commonly fringed by a scarp on the southern or eastern edges. *Eucalyptus bleeseri* is dominant on lateritic plateaux on skeletal laterite. *Calytrix exstipulata — C. achaeta* Alliance is restricted to exposed laterite. *Eucalyptus tetrodonta* is prominent on broken country with areas of deeper soil and increased run-off.

Soils are mostly skeletal laterites.

Main occurrences of the Foster Land System are in the south-east of the Peninsula, with Barton and Napier Land Systems.

4. Pago Land System (P/P2)

Eucalyptus tetrodonta — E. miniata Association dominates the undulating sandstone country and gently sloping plains bounded by sandstone scarps on deep sandy soils.

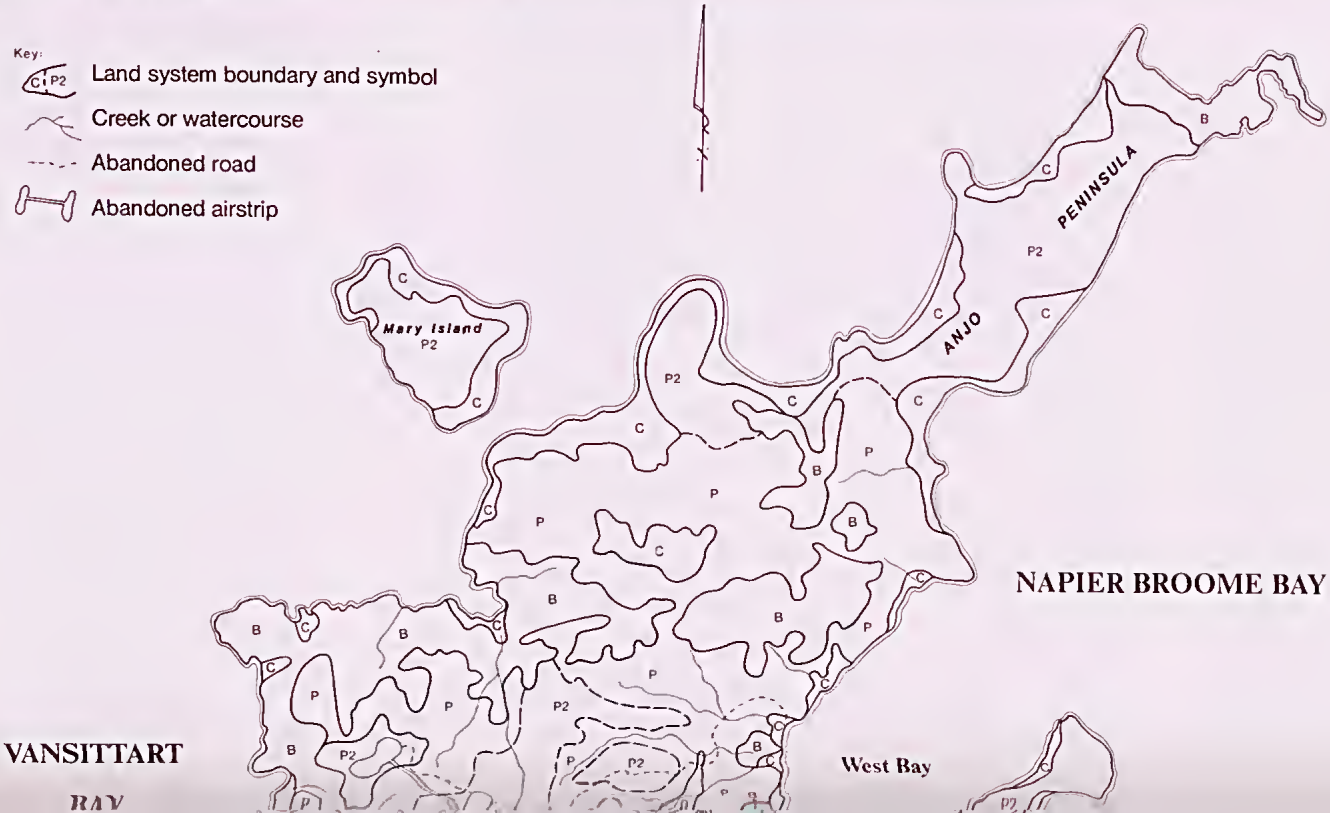
Unit 2 is distinguished by lateritic podzolic soils and occupies much of the northern, relatively flat areas of the Peninsula. Unit 2 includes significant occurrences of the *Eucalyptus latifolia — E. tetrodonta* Association, the *Eucalyptus polycarpa — E. apodophylla* Alliance and the *Eucalyptus bleeseri — E. tetrodonta — E. miniata* Association.

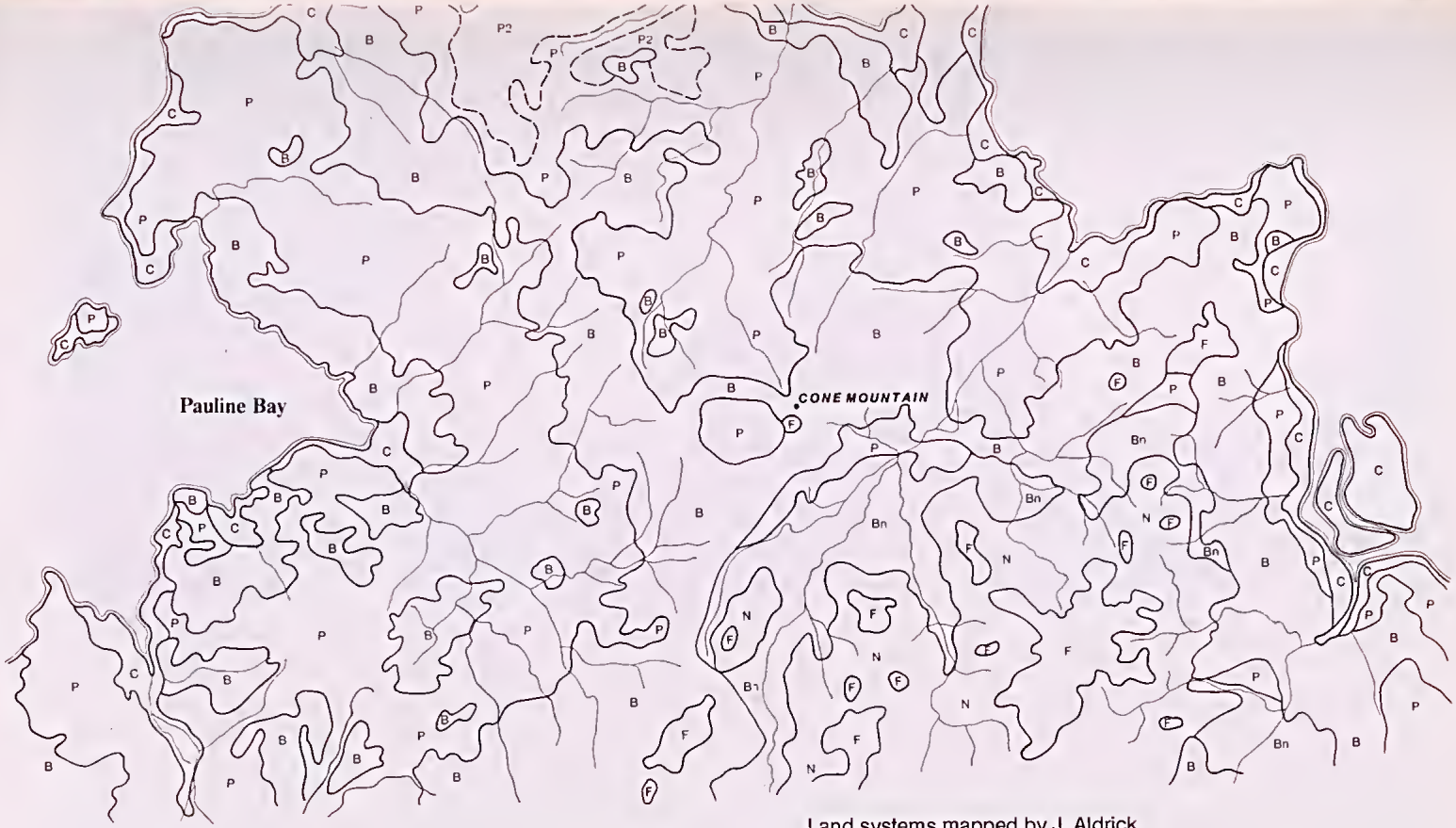
Soils are mostly deep yellow sands and lateritic podzolics (Unit 2).

The Pago Land System dominates the Peninsula.

Map 2 — Land systems of the surrounds of Vansittart Bay and Napier Broome Bay

Scale 1 : 80 000 approx.





Land systems mapped by J. Aldrick
Map draughted by L. Matthews.

5. Buldiva Land System (B)

Eucalyptus herbertiana Sub-alliance characterises the skeletal soils on rugged exposed sandstones.

Soils are mostly skeletal sands and bare rock.

The Buldiva Land System is second only to the Pago Land System within the Peninsula.

6. Carpentaria Land System (C)

Shore-line Communities occur on saline mud flats liable to flooding at high tide, coastal beaches (Unit 1a) and coastal dunes (Unit 1b).

The Carpentaria Land System occurs in depositional plains of Recent origin.

PREVIOUS VEGETATION STUDIES

Speck (1960a) and Lazarides (1960) published the first comprehensive account of vegetation in the Kimberley based on air photo interpretation and limited ground traverse (Stewart 1960). A total of 76 vegetation and 15 pasture units are defined on the basis of dominant overstorey species, structure and pasture species. Although the vegetation units are not mapped as such, recurring patterns of topography, soils and vegetation are mapped as land systems by Speck (1960c). The general distribution of vegetation units may be inferred from the land systems map. The difficulty of mapping the vegetation units themselves is discussed by Beard (1979).

The 1:1,000,000 vegetation map and explanatory notes of Beard provide the foundation to contemporary studies of Kimberley vegetation. Beard recognises six mapping units within the study area. Later, more detailed survey on the Bougainville Peninsula recognises nine mapping units (Beard, Clayton-Greene & Kenneally 1984) in an area only resolvable into 2 units at the 1:1,000,000 scale.

A detailed report on the vegetation and flora of the Mitchell Plateau, about 70 km south-west of the study area recognises 21 vegetation types (Hnatiuk & Kenneally 1981).

Preliminary surveys are available for Cape Londonderry (George 1978), the Drysdale River National Park (Kabay & Burbidge 1977); and the islands of the north-west Kimberley (Burbidge and McKenzie 1978.

VEGETATION COMMUNITIES

The vegetation of the study area has been subdivided into 19 units which have been named in accord with Speck (1960a) and Hnatiuk & Kenneally (1981) as far as possible. The units are described from observations made at the collecting sites (see Map 1) and are intended as a preliminary description. More intensive sampling, especially during the Wet season, would allow a more comprehensive classification of the vegetation.

The use of the terms alliance, association and community therefore follow Beadle and Costin (1952) and Beadle (1981). Association is used as the basic unit of classification and associations have been grouped into alliances and sub-alliances.

Figure 3. *Eucalyptus tectifica* sub-alliance dominated by *E. tectifica*, *Sorghum stipoideum*, *Dichanthium tenuiculum* and *Chrysopogon latifolius*, 3.5 km east of

The association is defined as a community in which the dominant stratum exhibits uniform floristic composition, the community usually exhibiting uniform structure. Community is here applied as a general term. Vegetation structure is defined in accord with Specht, Roe & Broughton (1974). The independence of the overstorey and ground storey vegetation in the Kimberley is remarked on by Beard (1979) however within the study area there is a reasonable consistency of association. The distribution of vegetation units within the study area is determined by the interaction of geology, soils and topography. These factors are discussed in the vegetation descriptions and each unit is allocated to one or more land systems.

Air photo interpretation, soil profiles and field notes on vegetation and geology provide the basis for a vegetation classification that is in accord with previous studies of the northern Kimberley. A generalised vegetation and geological map (Map 1) has been prepared based on LANDSAT imagery and interpretation of the Drysdale-Londonerry 1:250,000 Geological Series map sheet (Gellatly & Sofoulis 1969).

1. EUCALYPTUS TECTIFICA SUB-ALLIANCE (Figure 3)

E. tectifica Association 1

A park-like low open-woodland dominated by *Eucalyptus tectifica* and referable to the *E. tectifica* Association of Speck (1960a) was observed near Cone Mountain (on traverse from Woppinbie Creek). Scattered small trees of *Planchonia careya* form a very sparse understorey. *Planchonia careya* forms an orchard-like woodland in local depressions, sometimes with occasional stunted *Eucalyptus tectifica*. *Terminalia* spp. may replace *Planchonia careya* in other sites (as observed south of Kalumburu). The ground storey is dominated by perennial grasses to 0.5 m including *Themeda triandra, Sehima nervosum, Dichanthium tenuiculum* and *Chrysopogon latifolius*.

The annual cane-grass, *Sorghum stipoideum*, overtops the perennials but is rather sparsely distributed. The soil is the Fine-textured Yellow Podzol of Speck (1960b), developed on basalt from Carson Volcanics.

The Association is restricted to the Barton, Napier and Foster Land Systems and the principal occurrences are in the south of the study area.

2. EUCALYPTUS TECTIFICA SUB-ALLIANCE

E. tectifica Association 2

A low woodland dominated by *Eucalyptus tectifica* was observed on the dissected basalt scarp of Seaflower Bay. The dominance of annual cane-grass, *Sorghum* spp., the presence of a sparse small tree layer including *Dolichandrone heterophylla, Erythrophleum chlorostachys* and the cycad, *Cycas basaltica* and the virtual absence of perennial grasses distinguish this from *Eucalyptus tectifica* Association 1.

The presence of the rare tree *Eucalyptus fitzgeraldii* in this Association is noteworthy.

Eucalyptus tectifica Association 2 is described and mapped as *E. tectifica* savanna woodland by Beard, Clayton-Greene and Kenneally (1984) for the Bougainville Peninsula. A similar association is reported for the Mitchell Plateau (Hnatiuk & Kenneally 1981).

Figure 4. *Eucalyptus herbertiana* sub-alliance and Riverine *Melaleuca leucadendra* community on Woppinbie Creek, 5 km east of Cone Mountain.

The Association is on Igneous Red Earths of Speck (1960b) between scree, boulders and massive outcroppings of basalt from Carson Volcanics on variable slope.

The Association is restricted to the Napier Land System fringing much of the Bougainville Peninsula within the study area.

3. EUCALYPTUS HERBERTIANA SUB-ALLIANCE (Figure 4)

A low open woodland with occasional scattered trees of *Eucalyptus herbertiana* and *E. ollaris* or *Eucalyptus* sp. aff. *papuana*. A diverse sparse understorey of small trees characterise the sub-alliance. *Ficus platypoda, Owenia vernicosa, Petalostigma pubescens, Planchonella pohlmanniana, Terminalia carpentariae* and *Xanthostemon paradoxus* are locally dominant. *Eucalyptus brachyandra* is an occasional small tree, especially on steeper slopes. A very sparse ground layer includes *Plectrachne pungens* and *Trachymene didiscoides*.

Eucalyptus ollaris [*E. dichromophloia* auct.] has a broad ecological amplitude and is less useful for describing the sub-alliance.

The sub-alliance is restricted to the rugged, outcropping King Leopold Sandstones and associated skeletal sandy soils.

The sub-alliance is widespread in the study area and is restricted to the Buldiva Land System.

4. EUCALYPTUS TETRODONTA SUB-ALLIANCE

Eucalyptus tetrodonta Association

A low open forest/woodland dominated by *Eucalyptus tetrodonta* with a floristically depauperate understorey dominated by *Sorghum stipoideum* was observed on shallow, gravelly sands at West Bay. The Association is reported by Speck (1960b), and is restricted to areas of the Pago Land System.

The soil is described as Coarse-textured Yellow Podzolic by Speck (1960b) and is formed on the King Leopold Sandstones.

5. EUCALYPTUS TETRODONTA SUB-ALLIANCE

Eucalyptus tetrodonta — E. miniata Association

An open forest dominated by *Eucalyptus tetrodonta* and *E. miniata* with well developed small tree and shrub layers.

Small trees include *Erythrophleum chlorostachys, Buchanania obovata* and *Gardenia* spp. Common shrubs are *Petalostigma pubescens, Grevillea agrifolia* and *Acacia translucens*.

The ground layer includes the annual cane grass *Sorghum stipoideum* and coarse perennial grasses, typically *Plectrachne pungens*. The Association is reported by Speck (1960b) and occurs on sandy yellow earths (referred to as Deep Yellow Sands by Speck 1960b).

The *Eucalyptus tetrodonta — E. miniata* Association is the most widespread association in the study area and is characteristic of the Pago Land System.

Figure 5. *Eucalyptus bleeseri-E. tetrodonta-E. miniata* association on lateritised sandstone (or basalt) on Pim Hill.

6. EUCALYPTUS TETRODONTA SUB-ALLIANCE (Figure 5)

Eucalyptus bleeseri — E. tetrodonta — E. miniata Association

An open forest dominated by *Eucalyptus bleeseri*, *E. tetrodonta* and *E. miniata* in varying proportions. A sparse small tree layer includes isolated plants of such species as *Erythrophleum chlorostachys*, *Buchanania obovata*, *Planchonia careya* and *Owenia vernicosa*. The shrub layer is typically inconspicuous but *Acacia* and *Grevillea* species are locally prominent.

The ground storey is dominated by annual cane grass, *Sorghum stipoideum* and hummock grass, *Plectrachne pungens*.

The Association is reported in Speck (1960a) and occurs on lateritic podzols, laterite and partially lateritised sandstones (Lateritic Podzolics and Skeletal Laterite of Speck 1960b).

Eucalyptus bleeseri forms almost pure stands on skeletal laterite. The Association is similar to the *Eucalyptus tetrodonta — E. miniata*. Alliance reported by Hnatiuk and Kenneally (1981) from the Mitchell Plateau where *E. nesophila* replaces *E. bleeseri* and the fan-palm, *Livistona eastonii* is characteristic. The differences may be partly explained by the higher rainfall on the Mitchell Plateau.

The Association is typical of the Pago and Foster Land Systems.

7. EUCALYPTUS TETRODONTA — E. MINIATA ALLIANCE

An open forest dominated by *Eucalyptus nesophila* was noted on the dissected basalt surrounding the lateritic plateau near August Point on the Anjo Peninsula. The reader is referred to Hnatiuk and Kenneally (1981) and to Beard, Clayton-Greene and Kenneally (1984) for discussion of this vegetation type.

8. EUCALYPTUS LATIFOLIA ALLIANCE (Figure 6)

Eucalyptus latifolia — E. tetrodonta Association

A low open forest dominated by *Eucalyptus latifolia* and *E. tetrodonta* in varying proportions. *Grevillea pteridifolia* is a characteristic small tree and *Buchanania obovata* and *Planchonia careya* are also noteworthy.

Grevillea agrifolia, *Petalostigma pubescens* and *Acacia* spp. form a sparse shrub layer. *Plectrachne ? pungens* and the annual cane grass *Sorghum stipoideum* characterise the ground layer.

The Association was observed on Coarse-textured Yellow Podzolics (Speck 1960b) and on lateritic podzolics on the Anjo Peninsula and near Woppinbie Creek.

The Association is a minor component of the Pago and Barton Land Systems and is reported by Speck (1960a).

9. EUCALYPTUS LATIFOLIA ALLIANCE

A low woodland dominated by widely scattered *Eucalyptus latifolia*, *E. nesophila* and *Eucalyptus* sp. aff. *papuana* above small trees including *Buchanania obovata* and *Terminalia canescens* occurs on the bauxitic plateau of the Bougainville Peninsula on the northern arm of Seaflower Bay. The ground layer is dominated by *Sorghum* sp. and *Plectrachne ? pungens*.

Figure 6. *Eucalyptus latifolia-E. tetrodonta* association on lateritic podzolic, 3.5 km east of Cone Mountain.

The site is intermediate between the *Eucalyptus latifolia* Alliance of Hnatiuk and Kenneally (1981) and the pindan formation of Beard (1979). The reader is referred to Beard, Clayton-Greene and Kenneally (1984) for discussion of this vegetation type.

10. EUCALYPTUS POLYCARPA — E. APODOPHYLLA ALLIANCE

Eucalyptus polycarpa Association

A widespread open forest on the Anjo Peninsula dominated by *Eucalyptus polycarpa*. A prominent small tree layer varies in composition principally in relation to drainage. *Grevillea pteridifolia*, *Melaleuca viridiflora* and *Planchonia careya* may be prominent on drier sites whilst *Banksia dentata* and *Melaleuca leucadendra* prefer waterlogged sites. Shrubs include *Grevillea agrifolia*, *Petalostigma pubescens* and *Acacia* spp.

The grasses, *Sorghum* sp., *Plectrachne ? pungens* and the hummock fern *Platyzoma microphyllum* occur in the ground layer.

The Association is listed by Speck (1960a) and was noted on poorly drained rudimentary podzols on King Leopold sandstones (the Deep Light Grey Sands of Speck 1960b).

The Association is typical of poorly drained areas of the Pago Land System.

11. EUCALYPTUS POLYCARPA — E. APODOPHYLLA ALLIANCE

A high water table (between 45 cm and 130 cm from the surface in May 1984) extending over low-lying areas adjacent to a freshwater stream flowing into Pauline Bay supports a floristically rich open forest.

The dominant trees are *Eucalyptus ? bigalerita*, *E. alba*, *E. papuana* and *Syzygium bleeseri* subsp. *bleeseri*. Small trees are *Grevillea pteridifolia*, *Banksia dentata*, *Melaleuca* spp. and screw palms, *Pandanus* spp. The ground storey is a rich sward of annual and perennial grasses including annual cane grass *Sorghum stipoideum*, *Eulalia mackinlayi* and *Mnesithea rottboellioides* and annual forbs including *Mitrasacme* spp., *Stylidium* spp. and *Utricularia* spp.

The vegetation is a complex of the *Eucalyptus apodophylla* Alliance, *Melaleuca leucadendra* Alliance, *Pandanus* spp. Alliance and Aquatic Communities reported by Hnatiuk and Kenneally (1961) from the Mitchell Plateau and is not reported *per se* by Speck (1960a).

The Association occurs on rudimentary podzols (the Deep Light Grey Sands of Speck 1960b) and humic gley over King Leopold Sandstones. The Association occurs in the Pago and Buldiva Land Systems.

12. MELALEUCA SPP. ALLIANCE

Melaleuca viridiflora Association

Melaleuca viridiflora stands with scattered smaller trees of *Hakea arborescens* and *Planchonia careya* above a sparse herbaceous understorey occur on the tip of the Anjo Peninsula. The vegetation is listed by Speck (1960a) and was observed on a seasonally wet rocky shelf on a rudimentary gleyed podzolic.

Figure 7. *Acacia gonocarpa* community on sandstone, West Governor Island.

13. CALYTRIX EXSTIPULATA — C. ACHAETA ALLIANCE

A low or tall shrubland dominated by *Calytrix exstipulata* confined to exposed laterite and sandstone lithosols. The Alliance is described from the Mitchell Plateau by Hnatiuk and Kenneally (1981), and is mapped as a component of 'pindan' on the Anjo Peninsula by Beard, Clayton-Greene and Kenneally (1984).

The Alliance is widespread but of limited extent throughout the study area.

14. ACACIA COMMUNITIES (Figure 7)

Acacia scrubs from 1.5-3 m high are widespread on the Anjo Peninsula and on Governor Island. The scrubs are composed of various species including *Acacia dunnii* and *A. gonocarpa* on Governor Island and *Acacia gonocarpa, A. stigmatophylla* and *A. tumida* on the Anjo Peninsula.

Fire killed trees of *Eucalyptus bleeseri* on the Anjo Peninsula near Sharp Point provide evidence that some of the *Acacia* scrubs represent early successional stages after fire. The dynamics of vegetation response to fire and other disturbance is beyond the scope of the present study.

15. RIVERINE COMMUNITIES (Figure 8)

The vegetation of stream banks and levees is typically an open forest dominated by *Eucalyptus papuana, E. alba* and *Melaleuca leucadendra*. Small trees include *Lophostemon grandiflorus, Emmenosperma alphitonioides* and *Pandanus* spp. The gentle topography of stream courses at West Bay and Pauline Bay impedes drainage and the resulting high water table supports a *Eucalyptus polycarpa — E. apodophylla* Alliance. Although well developed riverine communities were encountered on traverses near Woppinbie Creek these sites were not adequately sampled. The communities would be included in the *Eucalyptus papuana* Alliance of Speck (1960a).

16. VINE THICKETS (Figure 9)

A dry rainforest described as 'vine thicket' by Beard, Clayton-Greene and Kenneally (1984) covers much of the shoreline and lower slopes of the Anjo Peninsula at Seaflower Bay. The vine thicket is a floristically diverse low closed forest. Allen (1971) provided the first account of vine thickets in the Kimberley region, and subsequent observations have been recorded by Beard (1976), Hnatiuk, and Kenneally (1981) and Beard, Clayton-Greene and Kenneally (1984), to which the reader is referred. Fire is considered to be the principal factor determining the distribution of vine thickets on the basalts leading to the plateau of the Anjo Peninsula.

Dominant trees at the sites visited on Seaflower Bay include *Celtis philippinensis, Randia cochinchinensis, Trema aspera* and *Zizyphus quadrilocularis* on drier sites. *Garuga floribunda* was prominent along an ephemeral stream course.

A depauperate vine thicket on the sandstone cliffs of Governor Island was variously dominated by *Pouteria sericea, Zanthoxylum parviflorum* and *Ficus* spp., with *Flagellaria indica* and *Ampelocissus acetosa* common creepers. Detailed investigations of Kimberley vine thickets by Kenneally (and others) are currently in progress (see McKenzie, Kenneally and Winfield 1987).

Figure 8. Riverine community and surrounding *Eucalyptus polycarpa* associations on unnamed creek flowing into Pauline Bay.

17. SHORE-LINE COMMUNITIES

1. Mangrove Alliance

Seven species of mangroves are included in the species list from Vansittart Bay and Napier Broome Bay, although the composition of mangrove communities was not recorded in detail. Wells (1981) and Hnatiuk and Kenneally (1981) discuss mangrove communities for the coastline adjoining the western side of the study area.

2. Strand-line Communities

Sandy shores are characterised by a number of sub-communities. Sporadic shrubs include *Euphorbia plumerioides*, *Scaevola sericea* and *Thespesia populneoides*. *Canavalia rosea* is a common creeper, and *Spinifex longifolius* and *Fimbristylis sericea* are common graminoids.

Hypersaline flats surrounding a lagoon near Sharp Point are dominated by a low open shrubland of *Halosarcia indica*, *H. halocnemoides* and *Neobassia astrocarpa*.

3. Exposed Rocky Shorelines

Exposed rocky shorelines are dominated by wind pruned small trees including *Drypetes lasiogyna*, *Gardenia* sp. nov. aff. *megasperma* and *Mimusops elengi*.

Table 1.

SOME EDAPHIC RELATIONSHIPS

Plant species	Soil conditions indicated
Eucalyptus miniata	A shallow-rooted tree. Survives well on laterite or rocky country, with shallow or droughty soils.
Eucalyptus tetrodonta *Erythrophleum chlorostachys*	These are deep-rooted trees that do best on deep sandy to loamy soils.
Eucalyptus latifolia	Prefers seasonally wet and seasonally dry loamy soils, often shallow and rocky.
Eucalyptus bleeseri	Diagnostic of very shallow droughty soils on laterite, with laterite outcrop.
Eucalyptus polycarpa *E. papuana* *E. bigalerita*	These eucalypts thrive in wet areas. *E. polycarpa* indicates seasonally swampy conditions. *E. papuana* will do well only if all-year-round soil moisture supplies are apparent, and *E. bigalerita* prefers drainage lines with loamy soils.
Eucalyptus tectifica *E. foelscheana* *E. fitzgeraldii*	*E. tectifica* is the common box tree on loamy soils, often in company with *E. foelscheana*. *E. fitzgeraldii* prefers the heavier textures, often structured, red earths.

Calytrix spp.	These indicate bare or almost bare laterite; rarely other rock.
Melaleuca viridiflora	This *Melaleuca* usually indicates conditions that are both very wet (waterlogged) in the wet season and very dry (droughty) in the dry season.
Owenia vernicosa *Gardenia* spp.	These plants grow well on the drier sandy soils.

CONSERVATION SIGNIFICANCE

The vegetation communities observed are typical of large areas of the northern Kimberley. Conservation of rainforest communities in the Kimberley is the subject of a more detailed investigation by one of us (KFK). Ethnobotanical studies for the area have been reported by Crawford (1982).

The most significant aspect of the Anjo Peninsula is that it is isolated; bounded by the sea and rugged sandstones. Feral stock are present in limited numbers and the vegetation is in good condition. The Riverine Communities, such as those at Pauline Bay are largely undisturbed and are significant for this reason. Fire ecology in the study area requires further investigation. The absence of settlement reduces a significant source of ignition and the frequency of fire has probably diminished since the end of the Second World War.

A number of species of significance occur within the study area, however further investigations in the Kimberley may reveal a wider distribution. In particular a number of *Hibiscus* species currently being investigated by Lyn Craven (CANB) appear endemic to the region. *Nymphoides disperma* is known from only two sites in the northern Kimberley. *Eucalyptus fitzgeraldii* on the Bougainville Peninsula also has an extremely restricted distribution. Numerous other species are also considered rare or localized, but in the absence of detailed floristic records from the Kimberley, assessment of the conservation status of such species is difficult.

The survey is not comprehensive and communities and species with a limited range, such as the *Eucalyptus ceracea* community above Casuarina Creek on the Londonderry Peninsula (see Brooker and Done 1986), could easily be overlooked within the study area.

The geomorphology of the Anjo Peninsula contains no known unique features.

The Anjo Peninsula has few records of European man other than the transitory occupation during the Second World War. Evidence of Aboriginal man is widespread.

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Figure 9. Vine Thicket on sandstone cliffs, *West Governor Island*.

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H.I. Aston (MEL) — Aquatics
R.M. Barker (AD) — Acanthaceae
W.R. Barker (AD) — Scrophulariaceae
B.A. Barlow (CANB) — Loranthaceae
M.I.H. Brooker (FRI) — *Eucalyptus*
R.C. Carolin (SYD) — Goodeniaceae
D.G. Catcheside — Bryophyta
W.L. Chew (NSW) — *Ficus*
R.J. Chinnock (AD) — Pteridophyta
B.J. Conn (NSW) — *Mitrasacme*, Lamiaceae
L. Craven (CANB) — *Hibiscus*, misc.
C.R. Dunlop (DNA) — Asteraceae, misc.
S. Fiddian (MELU) — Cyanophyta
R.B. Filson (MEL) — Lichens
D.B. Foreman (MEL) — Proteaceae, misc.
G.P. Guymer (BRI) — *Brachychiton*, misc.
R. Henderson (BRI) — Liliaceae
K. Hill (NSW) — *Eucalyptus*
R.W. Johnson (BRI) — Convolvulaceae
L.A.S. Johnson (NSW) — *Eucalyptus*
G. Kraft (MELU) — seaweeds
M. Lazarides (CANB) — Poaceae
B.R. Maslin (PERTH) — *Acacia*
L. Pedley (BRI) — *Tephrosia*, *Polycarpaea*
C. Puttock (UNSW) — *Gardenia*
P. Robbins (MELU) — seaweeds
J.H. Ross (MEL) — Caesalpiniaceae, Papilionaceae
P.S. Short (MEL) — Asteraceae

I.G. Stone — Bryophyta
P. Taylor (K) — *Utricularia*
J.G. West (CANB) — *Dodonaea*
P. Weston (NSW) — *Boronia*
J.H. Willis — Fungi
K.L. Wilson (NSW) — Cyperaceae
P.G. Wilson (PERTH) — Rutaceae

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AN ANNOTATED PLANT CHECKLIST OF VANSITTART AND NAPIER BROOME BAYS, NORTHERN KIMBERLEY, WESTERN AUSTRALIA

ARRANGEMENT OF THE PLANT CHECKLIST

Genera and species are arranged alphabetically within the families which are themselves arranged alphabetically in each section. Introduced plants are indicated by an asterkisk (*). Species are followed by the collector's initials, a collector's number or numbers to assist location of the voucher collections. Initials refer to the following collectors: EAC (E.A. Chesterfield), SJF (S.J. Forbes), WAP (W.A. Papst), PGW (P.G. Wilson) and JHW (J.H. Willis). All specimens cited are represented by voucher specimens housed either in the National Herbarium of Victoria (MEL) or the Western Australian Herbarium (PERTH), unless indicated by SR which denotes a sight record only.